Radiation response of nanostructured austenitic stainless steels

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Nanostructured metals are appealing candidate structural materials for advanced nuclear reactors due to their excellent resistance to energetic particle radiation. The radiation tolerance originates from abundant grain boundaries that serve as effective defect sinks in the steels, and thus mitigate the radiation-induced damage. However, grain boundaries are often unstable under radiation at high temperatures ($\geq 0.4T_m$). Here, we investigated the radiation response of a nanocrystalline (NC) 304 austenitic stainless steel (SS) with nanograins and an additively manufactured (AM) 316 SS with high-density solidification cellular structures via *in situ* Kr^{++} irradiation technique at elevated temperatures. The study shows that the NC 304 SS exhibits an excellent radiation tolerance in terms of a sluggish defect cluster accumulation and a low void swelling rate and the nanograins have outstanding thermal stability. In the AM 316 SS, solidification cellular walls can serve as effective defect sinks during the high temperature irradiation. The mechanisms of the enhanced radiation resistance in the nanostructured austenitic SS are discussed. The present study provides an opportunity for the application of nanostructured steels in advanced nuclear reactors.

Keywords: nanostructured austenitic stainless steels, *in situ* radiation, thermal stability, radiation resistance, irradiation-induced damages.